VIII. "Further observations on the Amyloid Substance met with in the Animal Economy." By ROBERT M'DONNELL, M.D. Communicated by WILLIAM BOWMAN, Esq. Received May 30, 1864.

In the early part of last year I had the honour of making a communication to the Royal Society "On the Amyloid Substance of the Liver, and its ultimate destination in the Animal Economy." The discussion which followed the reading of this paper made it desirable that further observations should be made regarding the natural history of this substance, more particularly with reference to its relations to the tissues of the fœtus. It was not possible to complete these investigations until the spring of the year placed at my disposal fœtal lambs, calves, &c. in various stages of development. This has been the cause of the delay in forwarding the present communication, for which I must apologise to the Society.

The amyloid substance met with in the fœtal tissues is in chemical composition identical with that found in the liver. Absolutely pure specimens, prepared from each of these sources, are represented by the formula $C_{12} . H_{10} . O_{10}$*.

With reference to its optical properties, it was stated in my former communication, on the authority of French observers, that amyloid substance of animal origin, like vegetable dextrine, causes the plane of polarization to deviate to the right; I must now confess that I have not been able to verify this assertion. It is not possible, by any means that I have been able to devise, to obtain a solution of this substance so transparent as to admit of its being submitted to examination in the saccharometer. If a portion of the liver of an adult animal, or of the muscular tissue or lung of a fœtus, be pounded to a pulp in a mortar with silver sand, and the whole afterwards mixed into a paste with animal charcoal and allowed to stand for some hours, and then treated with boiling distilled water and filtered, the liquid thus obtained is too turbid to permit of its rotatory power, as regards polarized light, being investigated. So small a quantity as half a grain of pure amyloid substance dissolved in an ounce of distilled water, produces in the solution a peculiar opalescent appearance. I have proved by experiment that this is not due to fluorescence, but to the fact that the amyloid substance has its particles merely in a state of suspension, not of true solution. No trace of it will pass through a dialyzer without the exercise of pressure, and the liquid thus obtained is not sufficiently translucent for examination by polarized light.

M. Charles Rouget and Professor Claude Bernard have examined the tissues of the fœtus microscopically, so as to determine the presence in

* In my former communication I gave an ultimate analysis of the amyloid substance of the liver, which Professor Apjohn, of Trinity College, Dublin, was good enough to make for me. But the specimen which I had furnished was not absolutely pure, containing a trace of nitrogen. The specimens from which the above formula is deduced were pure.

several of them of amyloid substance in abundance; but neither of these observers has attempted to show, by chemical investigation, at what period of development each of the tissues containing it is found to have it entering most largely into its composition. It must be remembered that the acidulated tincture of iodine is a test of such delicacy for this substance, that it produces its characteristic reaction even when the quantity of amyloid substance present is very minute *; hence, judging from the use of this test under the microscope, one is apt to suppose that the amount present is greater than it really is, or rather that it is equally abundant in tissues which in reality contain it in widely different quantities.

It was possibly owing to this mode of examination that Professor Bernard was led to suppose that this substance continues to exist in muscular tissue during the entire period of intra-uterine life, and that it does not disappear until after birth, when it does so under the influence of the respiratory and muscular movements. I hope to be able to show, however, that the establishment of respiration has little do with the disappearance of the amyloid substance from the tissues of the fœtus, and to prove that, in truth, certain azotized tissues are evolved from a nidus of amylaceous protoplasm, which, after a particular stage of growth, becomes less and less as each of those tissues approaches maturity, and that when maturity is attained the amyloid substance, which once formed so large an ingredient of the growing tissue, has gradually become changed so as to be no longer discoverable, even before respiration has commenced.

M. Rouget has quite correctly pointed out the very early period at which the amyloid substance is found in the cartilaginous tissue: it first shows itself in the cellules of this tissue; in the embryo chick and lamb, at a very early stage of development, it may be demonstrated; it very soon, however, disappears from the cells of cartilage and is too small in amount to be estimated at different stages of growth.

The epithelial cells of the skin are rich in amyloid substance at an early period. The points where cells aggregate themselves together for the commencing development of a feather or a hair, show a great abundance of the amylaceous material. The horny appendages of the skin, the bill of the embryo chick, the claws, hoofs, &c. of other embryos, contain it in large quantities up to a particular period of development. The feet of a fœtal calf of about four months were dried at a heat not exceeding 212°; 7 grains of the horny structure were rasped off, and on examination yielded 1·3 gr. of amyloid substance. An exactly equal quantity from the feet of a nearly full-grown fœtal calf, similarly treated, gave an amount of amyloid substance too minute to be estimated. It almost wholly disappears from the feathers when they become prominent on the surface, and for hairs the same may be said. If one of the large hairs from the eyebrow of a fœtal lamb, shortly before the time of birth, be examined, nothing more than a

* A tenth of a grain of amyloid substance may be readily detected in an ounce of water by the action of acidulated tincture of iodine.

mere trace of amyloid substance can be detected, and that only in the cells of the bulb. If a number of embryo lambs, of various sizes, are placed side by side, and a drop of a weak solution of iodine acidulated be allowed to fall on a corresponding part of each, the peculiar brown stain produced will be seen to increase in intensity up to a certain point. After the appearance of the hair, the stain gradually diminishes in intensity, showing the lessening quantity of amyloid substance in the tissue. If the tails cut off from a series of fœtal lambs are placed in a vessel containing a very weak solution of iodine acidulated, it illustrates (by the colouring) very strikingly the increasing abundance of the amyloid substance in the epidermic tissue up to a particular period (that is, when the hair is fully formed), and then its gradual disappearance. The feet and hoofs similarly treated illustrate the same for the horny tissue of this part. From the time that the fœtus of the sheep is nine inches in length (at which period the amyloid substance seems to be at its maximum), the amyloid substance contained in the horny structure of the hoof gradually diminishes until shortly before birth, when, even after prolonged boiling, scarcely a trace can be extracted from it.

In the tissue of the lung of mammalian embryos, the amyloid substance is at one period present in immense quantity. After the watery part is driven off by evaporation, more than 50 per cent. of the dry residue is found to be nothing else than animal dextrine. As the organ approaches maturity, and the animal is about being born, but before it has yet drawn a single breath, the amyloid substance is found to be reduced to a very small quantity indeed, and in some instances to have absolutely disappeared. The following Table shows the progress of this change in the lung of the embryo of the sheep, and, I believe, very closely represents the corresponding amount of change which takes place in the lung-tissue of other embryos which I have examined, viz. of the rabbit, cat, dog, cow, rat, guinea-pig.

	Size and condition of the embryo.	Amount of amyloid substance contained in 20 grains of the perfectly fresh lung-tissue.
1st.	Not quite 6 inches long, without any vestige of hair	1·9 grain.
2nd.	7 inches long; a trace of hair on the lip.....	2·55 grains.
3rd.	10 inches long; delicate hair about the head	2·8 grains.
4th.	15 inches long; covered with delicate hairs	3·45 grains.
5th.	16½ inches long; well covered with fine hair	2·2 grains.
6th.	Nearly 20 inches long; quite thickly covered with wool, and evidently very near the time of birth	A quantity too small to be estimated.

It would be no very easy matter to attempt to indicate precisely the condition of development of the embryo at which the maximum amount of amyloid substance is to be found in the tissue of voluntary muscle; in embryos of apparently the same age and condition of development it is found

to vary a good deal in amount. But this much may be asserted positively, that for some time before birth it has much diminished in quantity in this tissue, although always existing in it in notable amount up to and after birth. After repeated examination of various embryos, I believe I may state that the following Table, made from examination of the voluntary muscular tissue of fœtal lambs, correctly represents the average quantity of animal dextrine found in this tissue at various periods of its growth* :—

Size and condition of the embryo.		Quantity of fresh muscular tissue examined.	Weight of the foregoing when thoroughly dried.	Amount of amyloid substance in foregoing.
1st.	4 inches long.....	30 grains.	1·7 grain.	·1 grain.
2nd.	7 inches long; hair on lip	60 grains.	5·5 grains.	·5 grain.
3rd.	10 inches long; hair on head very fine	60 grains.	6·2 grains.	1·1 grain.
4th.	15 inches long; covered with delicate hair	60 grains.	7·5 grains.	2 grains.
5th.	16½ inches long; well covered with fine hair	60 grains.	7·8 grains.	2·1 grains.
6th.	Nearly 20 inches long, and almost about to be born	60 grains.	9·5 grains.	1·4 grain.

It appears therefore that, although it exists in a less proportion than at an earlier period, there is in muscular tissue at the period of birth a considerable quantity of amyloid substance; and this does not disappear altogether for some time in lambs, occasionally not for some weeks after birth. The tissue of voluntary muscle cannot be considered to have attained maturity at the time of birth; it has as yet hardly been called upon to exercise its functions. There is, however, a muscular organ the tissue of which commences, of necessity, the active exercise of its functions at an earlier period than that of voluntary muscle. The muscular structure of the heart, so far as its functions and activity are concerned, attains maturity

Size and condition of the embryo.		Weight of the muscular tissue of the heart examined.	Amount of amyloid substance in foregoing.
1st.	7 inches long	20 grains.	1·52 grain.
2nd.	10 inches long	20 grains.	1·60 grain.
3rd.	15 inches long	20 grains.	1·76 grain.
4th.	20 inches long, just before birth	20 grains.	A trace too small to weigh.

* It was stated in my former communication that 3·5 grains of amyloid substance was obtained from 60 grains of muscular tissue of a fœtal calf; but this was not quite pure, the investigation not being made with so much care as in the present instance.

earlier than other muscular tissue. The relation which the amyloid substance bears to it is therefore of much interest. In all embryos, without exception, which I have had an opportunity of examining at a time when they were closely approaching the period of birth, there has been no more than a trace of amyloid substance remaining in the muscular structure of the heart. The preceding Table, drawn up from examination of the heart of the embryo of the sheep, closely represents the corresponding state in other embryos.

The liver, which is the organ destined to form the amyloid matter during adult life, naturally has an increase of this material going on in its tissue up to and after birth: it does not make its appearance in the liver until the embryo is already well advanced in development; it then is found gradually and very slowly to increase in amount, but even at the time of birth is present in comparatively small quantity (2 per cent. in the liver of a lamb 20 inches long).

The rapidly growing horn of a young stag was not found to contain any amyloid substance in the tissues, neither does it exist in the texture of the growing horn of the calf; it is not found in the hair-bulbs of the adult, neither is it to be discovered as a formative material of the newly formed muscular fibres of the uterus when this organ is undergoing its remarkable reconstruction after delivery.

What is the function of this material during fœtal life? It can at least be said it does not change into sugar, neither does it give rise to fat. It seems to be a formative material, which, gradually becoming united with nitrogen, gives origin to the azotized structures.

IX. "Description of a New Mercurial Gasometer and Air-pump." By T. R. Robinson, D.D., LL.D., F.R.S., &c. Received June 2, 1864.

In some experiments on the electric spectra of metal and gases, I felt the want of a mercurial gasometer for working with such of the latter as are absorbable by water. That of Pepys is on too large a scale for my requirements, and it seemed better to contrive one more easily manageable, which I saw could also be made to act as a mercurial air-pump. In this I have succeeded to my satisfaction; and I hope that a description of it may be useful to those who are engaged in similar researches.

There have been several attempts made to exhaust by means of mercury, the chief of them with which I am acquainted being those of Close (Nicholson's Journal, 4to, iii. p. 264), Edelcrantz (Nicholson, 8vo, vii. p. 188), Traill and Children (Nicholson, xxi. pp. 63 & 161), and that of Geisler, which he uses in preparing the beautiful vacuum-tubes which bear his name. In all the principle is the same. A vessel is filled with mercury, which is made to descend from it, leaving in it a Torricellian